Chapter F2: Technical Description of the Brayton Point Station

This chapter presents technical information related to the Brayton Point facility. Section F2-1 presents an operational profile of the facility and includes Energy Information Administration (EIA) data on its generating units. Section F2-2 describes the configuration of the intake structures and water withdrawals.

CHAPTER CONTENTS

F2-1 Operational Profile

During 1999, the Brayton Point power plant operated eight active units.[1] Units 1-3 are coal-fired steam-electric generators; Unit 4 is an oil-fired steam-electric generator. Units 1-3 use cooling water withdrawn from the Taunton River; unit 4 uses water withdrawn from the Lee's River. The remaining four units are internal combustion turbines that do not require cooling water. All units became operational between August 1963 and December 1974.

Brayton Point's total net generation in 1999 was 8.7 million MWh. Unit 3 accounted for 4.4 million MWh, or 51 percent, of this total. Unit 1 and Unit 2 accounted for 1.8 million MWh (21 percent) and 1.7 million MWh (20 percent), respectively. The capacity utilization of Brayton Point's units ranged from 78 percent (Unit 3) to 86 percent (Unit 1). Unit 4 was on standby in 1999 and had a capacity utilization of only 18 percent.

Table F2-1 presents details for Brayton Point's eight units.

Table F2-1: Brayton Point Generator Characteristics (1999)

Generator ID	Capacity (MW)	Prime Mover[a]	Energy Source[b]	In-Service Date	Operating Status	Net Generation (MWh)	Capacity Utilization[c]	ID of Associated CWIS
1	241	ST	BIT	Aug. 1963	Operating	1,812,283	85.8%	1
2	241	ST	BIT	Jul. 1964	Operating	1,746,259	82.7%	2
3	643	ST	BIT	Jul. 1969	Operating	4,400,369	78.2%	3
4	476	ST	FO6	Dec. 1974	Standby	744,188	17.9%	4
IC1	2.8	IC	FO2	Mar. 1967	Cold Standby	204	0.8%	Not applicable
IC2	2.8	IC	FO2	Mar. 1967	Cold Standby	176	0.7%	
IC3	2.8	IC	FO2	Mar. 1967	Cold Standby	181	0.8%	
IC4	2.8	IC	FO2	Mar. 1967	Cold Standby	188	0.8%	
Total	**1,611**					**8,703,848**	**61.7%**	

[a] Prime mover categories: ST = steam turbine; IC = internal combustion.
[b] Energy source categories: Oil; BIT = bituminous coal; FO6 = No. 6 Fuel Oil; FO2 = No. 2 Fuel.
[c] For this analysis, capacity utilization was calculated by dividing the unit's actual net generation by the potential generation if the unit ran at full capacity all the time (i.e., capacity * 24 hours * 365 days).
Source: U.S. Department of Energy, 2001a and 2001c.

[1] For the purposes of this analysis, "active" units include generating units that are operating, on standby, on cold standby, on test, on maintenance/repairs, or out of service (all year). Active units do not include units that are on indefinite shutdown or retired.

F2-2 CWIS Configuration and Water Withdrawal

Brayton Point operates two distinct cooling water systems to serve its four generating units. Cooling Water System #1 (CWS #1) serves generating units 1-3 while Cooling Water System #2 (CWS #2) provides cooling water for the fourth generating unit. The operation of these two systems over time is summarized in Table F2-2 and discussed below.

Table F2-2: Brayton Point Timeline of CWIS Operations

Time Period	CWIS #1	CWIS #2
1963-1969	Units 1,2,3 put into operation. All three served by the same intake structure with the following configuration: ▸ Source water: Taunton River ▸ Six intake bays (2 for each unit) ▸ Conventional once-through system ▸ Trash rack ▸ Conventional traveling screen (rotated every 8 hours) ▸ High pressure spray wash (120 psi) to remove debris and fish ▸ Sluiceway to carry debris and fish to discharge point beyond the influence of the intake structure ▸ Design intake flow: 925 MGD *Seasonal Variation:* May to October of each year fixed screens are placed on the trash racks to prevent impingement of horseshoe crabs on the traveling screen. Fixed screens are hauled and washed as necessary.	N/A
1969-1973	Operations unchanged from above.	N/A
1974	Operations unchanged from above.	Unit 4 put into operation. Served by one intake structure with the following configuration: ▸ Source Water: Lee River ▸ One intake bay ▸ Closed-cycle cooling system ▸ Trash racks ▸ Conventional traveling screen (uncertain about rotation/cleaning schedule, but unlikely continuous)
1975-1981	Operations unchanged from above.	Operations unchanged from above.
1981	Operations unchanged from above.	Unit 4 begins piggyback operation. Water intake from Lee River ceases. All cooling water taken from discharges from CWIS #1
1982	Operations unchanged from above.	Piggyback operation.
1983	Unit 3 shut down for seven months. (8/83-2/84)	Piggyback operation.

Table F2-2: Brayton Point Timeline of CWIS Operations 1969-Present (cont.)

Time Period	CWIS #1	CWIS #2
1984	All units operational. No change from configuration above.	Unit 4 begins once-through cooling (7/15/84) with the following configuration: ▸ Source water: Lee River ▸ One intake bay ▸ Trash racks ▸ Angled traveling screens. Six traveling screens set 25° from upstream flow. ▸ Fish bypass intakes at the apex of angled screens. ▸ Fish baskets (with water retention) mounted to screens. ▸ Low-pressure spray to remove impinged fish. ▸ High-pressure spray to remove debris. ▸ Separate fish and debris troughs. ▸ Screens rotate at various speeds depending on water differential. ▸ Design intake flow: 395 MGD
1985	Unit 3 shut down for seven months. (8/85-2/86).	Fine mesh screens added to traveling screen structure from 3/85-9/85. All other operations remain unchanged.
1986-1993	Unit 3 shut down for six months (8/86-1/87).	Operates at original once-through configuration.
1993	Operates at original configuration.	Piggyback for one month (2/25/93-3/31/93).
1994	Operates at original configuration.	Piggyback operation for two months (2/18/94-4/29/94).
1995	Unit 3 shut down for 2 months (2/18/-4/30). Facility notes this is a "piggyback equivalent."	Operates at original once-through configuration.
1996	Operates at original configuration.	Piggyback operation for two months (2/27-4/30).
1997	MOA II instituted. Traveling screens begin continuous operation on CWIS #1. Facility-wide intake flow restricted to 925 MGD during the winter season and 1,130 MGD during the summer season. Unit 4 required to operate piggyback at least eight months of the year.	
	Traveling screens operate continuously.	Piggyback operation for eight months (2/6-3/30, 4/17-5/28, 10/2/97-5/27/98)
1998	No change from above.	Piggyback operation for eight months (10/1/98-5/30/99).
1999	No change from above.	Piggyback operation for eight months (10/9/99-5/30/00).
2000	No change from above.	Piggyback operation for eight months (9/29/00-5/3/01).

a. Cooling water system #1

First placed into service in 1963 with the commencement of operations in generating unit #1, CWS #1 consists of one cooling water intake structure to the east of the main facility that serves a conventional once-through system. A total of six intake bays (two for each generating unit) withdraw water from the Taunton River. The intake bay depth is approximately 6.1m below the mean sea level. Intake openings for bays 1-4 (serving generating units 1 and 2) are approximately 3.7m wide, while those for bays 5 and 6 are approximately 5.2m wide. Each intake bay shares the same technological configuration.

CWS #1 currently employs trash racks and a continuously-rotating traveling screen across each of its six intake bays. Neither technology is particularly effective at reducing impingement and/or entrainment losses. Cooling water withdrawn from the Taunton River first passes through the trash racks into the intake channel. Next are conventional traveling screens equipped with wire mesh panels with openings of 9.5mm^2. The screens continuously move in a vertical direction to remove impinged organisms and debris. Impinged items are washed off the intake screen with a high-pressure spray (120 psi) within the screen assembly. All debris is deposited in a sluiceway and carried to a discharge point approximately 300ft to the east of the intake structure.

CWS #1 modifies its intake operations seasonally to account for changes in available cooling water and migratory patterns of indigenous organisms. From May to October, fixed screens are placed on the trash racks to prevent impingement of horseshoe crabs on the traveling screens. Since 1993, Brayton Point has operated under a Memorandum of Agreement (MOA II) that effectively limits the maximum intake of CWS #1 to 925 MGD.

b. Cooling water system #2

CWS #2 began conventional once-through operation in 1984 with an angled screen assembly with fish buckets and a fish diversion/return system to reduce impingement mortality. No entrainment technology is currently in place.

An 18-month study conducted by the New England Power Company at the Brayton Point Station assessed the efficacy of the angled screen/fish diversion assembly in reducing impingement losses at CWS #2 (Lawler, Matusky & Skelly Engineers, 1987). The study calculated the Diversion Efficiency (DE) of the system (the percentage of organisms that are either impinged against the screen or diverted into the fish bypass pipe; this does not include entrained organisms) to be 76.3 percent. Excluding bay anchovy from the species increased the DE to 89.7 percent.[2] The Total System Efficiency (TSE) represents the probability that a fish entering the angled screen system will be returned to the source waterbody and survive for 48 hours. The study calculated the TSE of the system to be 33.1 percent. Excluding bay anchovy from the sample species increased the TSE to 55.4 percent.[3,4]

Originally designed as a closed-cycle system and placed into service in 1974 as the source of cooling water for generating unit #4, CWS#2 currently operates as a conventional once-through system to the north of the main facility. Water is withdrawn from the Lee River. The entire intake structure is approximately 44m long with an intake opening 34m. Cooling water enters the intake through eight 3.4m-wide openings that extend from a depth of 5.5m below the mean sea level to 1.2m above the mean sea level.

Cooling water withdrawn from the Lee River first passes through trash racks that extend to the bottom of the opening at an average approach velocity of 0.5 feet per second (fps). Downstream of the trash racks are six traveling screens angled 25˚ from the direction of flow in the intake waterway. The screens are set perpendicular to the screenwell floor and have 9.5mm^2 mesh panels. At the apex of the triangle formed by the angled screens are fish bypass inlets leading to two fish return pipes that carry unimpinged fish back to the Lee River. The screens rotate vertically on a continuous basis; the speed is determined by the differential in water height between the upstream and downstream sides of the screen face. Fish impinged against the traveling screens are captured in fish buckets mounted to each screen assembly. The fish buckets rotate with the screens while retaining sufficient water for any captured organisms. A low-pressure spray (5-10 psi) removes most aquatic organisms into a

[2] Bay anchovy are the dominant fish species, in terms of number, at the Brayton Point facility. Inordinately high impingement rates for bay anchovy occurred during a six-month test period during which fine mesh screens (1.0mm^2) replaced the 9.5mm^2 screens. Current operations only employ the wide mesh screens.

[3] *Ibid.*

[4] EPA does not typically use a 48-hour survival standard when determining the efficacy of an impingement technology. However, for the purposes of this case study only (Mt. Hope Bay), EPA will use the facility's determination.

separate fish trough which then carries them to the fish diversion pipe and back to the Lee River. A high-pressure spray (120 psi) washes remaining debris into a debris trough.

At maximum capacity, Brayton Point CWS #2 can withdraw 395 MGD from the Lee River. Since 1997, the facility has operated under MOA II, which limits the facility-wide intake flow during the winter months to 925 MGD. In an effort to reduce the entrainment of winter flounder during the spawning season, CWS #2 does not withdraw water from the Lee River from October through May. During this time, cooling water is obtained by diverting discharged water from CWS #1 to the intake canal for CWS #2 ("piggyback operation"). Generating units 1-3 typically discharge less heat as a result of operations, thereby making this process feasible. From 1984 (introduction of the once-through system for CWS #2) to 1997, piggyback operation was used intermittently. Table F2-3 summarizes the modes of operation of Unit 4 from 1973 through 2000.

Table F2-3: Modes of Operation of Brayton Unit 4 from 1973 to 1978

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1977	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC
1978	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC
1979	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC
1980	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC
1981	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB
1982	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB
1983	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB	PB
1984	PB	PB	PB	PB	PB	PB	OC	OC	OC	OC	OC	OC
1985	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1986	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1987	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1988	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1989	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1990	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1991	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1992	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1993	OC	OC	PB	OC	OC	OC	OC	OC	OC	OC	OC	OC
1994	OC	OC	PB	PB	OC	OC	OC	OC	OC	OC	OC	OC
1995	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC	OC
1996	OC	OC	PB	PB	OC	OC	OC	OC	OC	OC	OC	OC
1997	OC	PB	PB	PB	PB	OC	OC	OC	OC	PB	PB	PB
1998	PB	PB	PB	PB	PB	OC	OC	OC	OC	PB	PB	PB
1999	PB	PB	PB	PB	PB	OC	OC	OC	OC	PB	PB	PB
2000	PB	PB	PB	PB	PB	OC	OC	OC	OC	PB	PB	PB

Notes: CC = close-cycle cooling mode; OC = open-cycle mode; PB = piggyback mode.
Source: Personal communication, Meredith Simas, Environmental Engineer, Brayton Point Station, March 23, 2001.

F2-3 Brayton Point Generation

During 1999, the Brayton Point power plant operated eight active units.[5] Total net generation in 1999 was 8.7 million MWh. Unit 3 accounted for 4.4 million MWh, or 51 percent, of this total. Unit 1 and Unit 2 accounted for 1.8 million MWh (21 percent) and 1.7 million MWh (20 percent), respectively. The capacity utilization of Brayton Point's units ranged from 78 percent (Unit 3) to 86 percent (Unit 1). Unit 4 was on standby in 1999 and had a capacity utilization of only 18 percent.

[5] For the purposes of this analysis, "active" units include generating units that are operating, on standby, on cold standby, on test, on maintenance/repairs, or out of service (all year). Active units do not include units that are on indefinite shutdown or retired.

Table F2-4 presents details for Brayton Point's eight units.

Table F2-4: Brayton Point Generator Characteristics (1999)

Generator ID	Capacity (MW)	Prime Mover[a]	Energy Source[b]	In-Service Date	Operating Status	Net Generation (MWh)	Capacity Utilization[c]	ID of Associated CWIS
1	241	ST	BIT	Aug. 1963	Operating	1,812,283	85.8%	1
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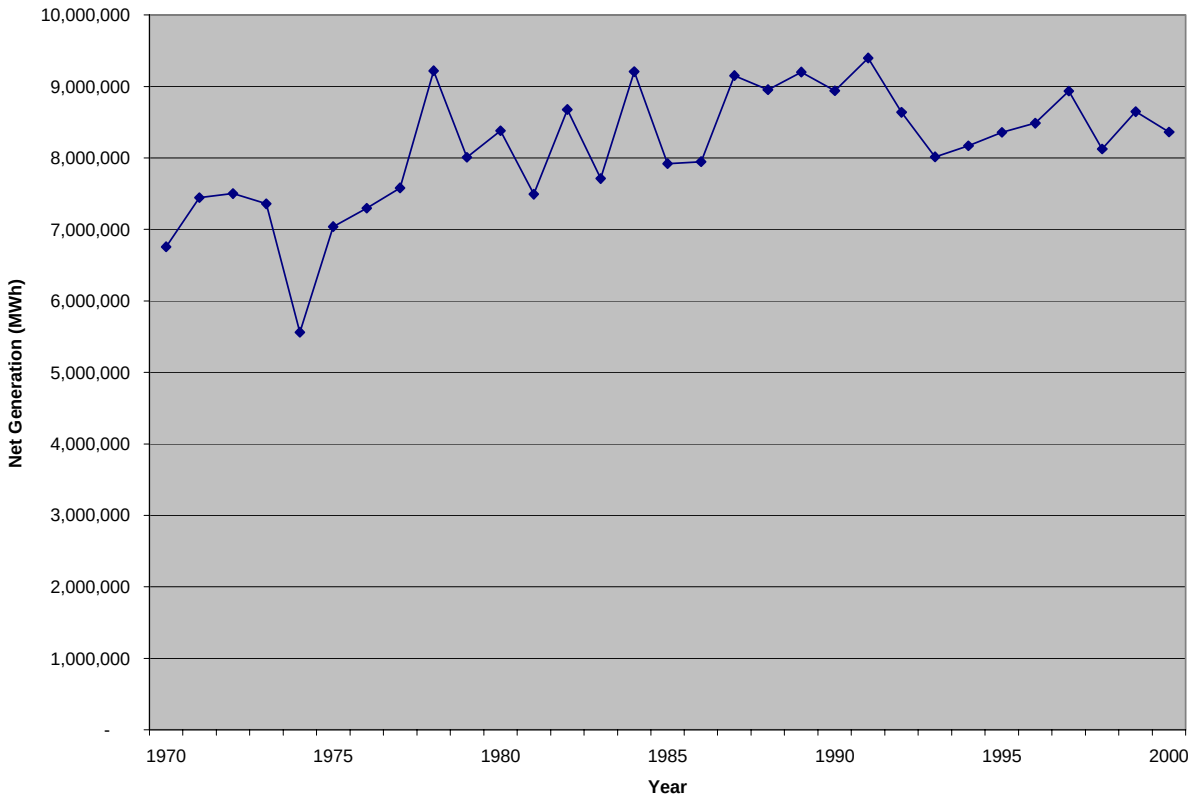
[a] Prime mover categories: ST = steam turbine; IC = internal combustion.
[b] Energy source categories: Oil; BIT = bituminous coal; FO6 = No. 6 Fuel Oil; FO2 = No. 2 Fuel.
[c] For this analysis, capacity utilization was calculated by dividing the unit's actual net generation by the potential generation if the unit ran at full capacity all the time (i.e., capacity * 24 hours * 365 days).
Source: U.S. Department of Energy, 2001c; U.S. Department of Energy, 2001a, for Net Generation and CWIS ID.

Figure F2-1 below presents Brayton Point's electricity generation history between 1970 and 2000.

Figure F2-1: Brayton Point Net Electricity Generation 1970 - 2000 (in MWh)



Source: U.S. Department of Energy, 2001c, 2001d.